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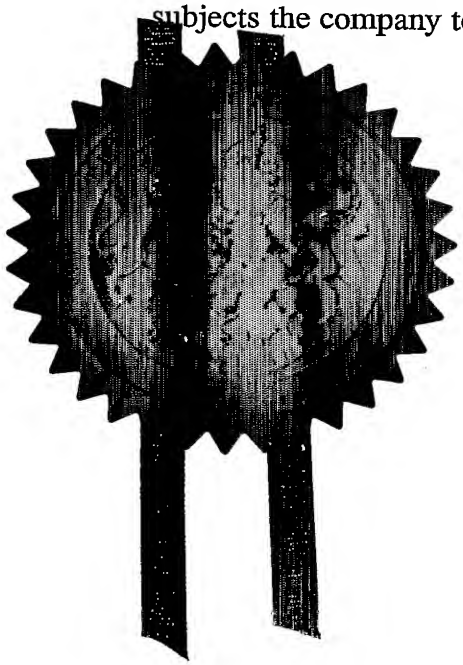

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2. **Patent application number** *(The Patent Office will fill in this part)* — 0404954.0

3. **Full name, address and postcode of the or of each applicant** *(underline all surnames)*

   John Charles Macintosh FORREST
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   CR8295 1200 1

   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation

4. **Title of the invention** — **AN APPARATUS AND METHOD FOR FLOOD DEFENCE**

5. **Name of your agent** *(if you have one)*
   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   BARON & WARREN
   19 SOUTH END
   KENSINGTON
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Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*

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Number of earlier application	Date of filing *(day/month/year)*

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Description	11
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Request for preliminary examination and search *(Patents Form 9/77)*

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Any other documents *(please specify)*

11. **I/We request the grant of a patent on the basis of this application.**

Signature **Date 04-03-04**

Baron & Warren

BARON & WARREN
Agents for the Applicant

12. **Name and daytime telephone number of person to contact in the United Kingdom** **Michael Robnson 020 7937 0294**

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AN APPARATUS AND METHOD FOR FLOOD DEFENCE

The present invention relates to an apparatus and method for flood defence.

Domestic and commercial properties built in low lying areas may be susceptible to flooding, particularly if they are built on a flood plain. Existing flood defences to protect such properties may comprise permanent bunds or walls of fixed height but these can deny access across the line of defence and can be unsightly. Alternatively, temporary defences immediately adjacent to the property are provided in the form of sandbagging and the sealing up of doors and windows which have the dual disadvantages of only protecting a small height of flood and being labour intensive to install and dismantle.

An object of the present invention is to provide an apparatus and method for flood defence which alleviates at least one of the above-mentioned problems.

According to one aspect of the present invention there is provided an apparatus for flood defence comprising at least one slab rotatable about an axis between a lowered and a raised positions, the slab forming at least part of a paved way when in its lowered position and comprising at least part of a flood barrier when in its raised position.

A flood barrier of a substantial height can thus be quickly erected / taken down by use of the apparatus and this increase in height may give a total flood defence height of the order of 1.5 to 2 metres. The apparatus forms at least part of an active defence when the or each slab is in its raised position. In addition, the view from any property being protected by a flood barrier comprising the apparatus is only temporarily obstructed whilst the the or each slab is in its raised position.

The paved way may comprise a pavement or footpath for pedestrians and/or a road for vehicles. Hence, the apparatus has a use when in its lowered position.

The apparatus may include a base wherein the at least one slab is rotatable relative to the base.

The apparatus preferably includes sealing means for forming a seal when the at least one slab is in its raised position. The sealing means may form a seal between the slab and the base when the slab is in its raised position.

There may be at least one abutment adjacent the slab. The sealing means may be arranged to form a seal between the slab and the adjacent abutment when the slab is in its raised position.

The apparatus preferably includes a plurality of said slabs rotatable about said axis. The sealing means may be arranged to form a seal between adjacent slabs when the slabs are in their raised position.

In order that the slabs may be raised individually, the means of sealing between a said slab and an adjacent abutment or slab preferably comprises at least one removable portion. The removable portion may comprise a removable board. There may be wedging means for urging the removable board against at least one seal. The wedging means may comprise a scissor action device which is able to provide a wedging action. The device may comprise crossed metal tapered flats in "scissor" form.

The sealing means between a said slab and an adjacent abutment or slab preferably forms a continuous seal with the sealing means between the at least one slab and base when the at least one slab is in its raised position.

There may be at least one strut or prop for supporting at least one said slab in its raised position. The strut may be used to tighten the slab against the seal between the slab and the base when the slab is in its raised position and the strut may be removable.

The apparatus provides a raised flood barrier by simply rotating the at least one slab to its raised position, inserting the sealing means between the slab(s) and abutments and, if necessary, inserting struts. This operation is capable of being conducted in a matter of only minutes by unskilled labour.

The at least one slab may be substantially balanced about the axis. This

enables the slab to be rotated manually into its raised position without having to rely on a powered driving means which may, for example, require either electrical or hydraulic power supplies or a combination of both. The slab may be finely balanced for movement by fingertip action.

The apparatus may include mechanical means, such as a hydraulic ram, for rotating the at least one slab between the lowered and the raised positions.

The apparatus may include locking means for locking at least one said slab in its lowered and/or raised positions.

The base may include a channel portion. The base may comprise an upstand extending into the channel portion which supports the or each slab for rotation. Alternatively, a side portion of the channel portion supports a hinge about which the at least one slab rotates.

The channel may have a protruding portion extending beneath the base.

The flood defence apparatus may have a substantial portion of the base projecting above ground level so that the apparatus provides a first level of flood defence when the or each slab is in its lowered position and the apparatus is arranged to provide a higher second level of flood defence when the or each slab is in its raised position. The first level of flood defence is a passive defence and may comprise at least part of a shallow raised bund around part or all of the building(s) to be protected. The apparatus can be landscaped into the grounds of a building such as a garden of a home. There would be no obstruction to the view to the grounds of the building from a ground floor window when the apparatus is providing a first level of flood defence.

The slab may comprise different portions with different densities and this enables the slab to be balanced when the slab is not centrally positioned relative to the axis. This may be achieved by the slab having a bracket or rack or racking supporting balancing weights. A suitable slab may be approximately 3 to 5 metres long and 1.5 to 2 metres wide. In a preferred embodiment, the slab is approximately 3 metres long, 1.5 metres wide and 15 centimetres thick and may include an edge frame. This is a typical size for ease of transport to the site and

erection and for infilling the frame of the slab with concrete. The axis of rotation and centre of gravity may be positioned at a third of the width of the slab in from one of its edges. This position may be varied by, for example, by rearranging the slab's balancing weights, their support brackets and the space occupied by these weights when the slab is in its raised position in order to vary the height of a flood barrier when the slab is in its raised position.

According to another aspect of the present invention there is provided a method for flood defence comprising the steps of:

providing at least one slab forming at least part of a paved way in a lowered position; and

rotating the at least one slab about an axis from the lowered position to a raised position to comprise at least part of a flood barrier.

The apparatus and method requires no untried techniques or technology.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which:-

Figures 1 and 2 are a schematic plan and sectional view, respectively, of a flood defence incorporating the apparatus according to a first embodiment of the invention;

Figure 3 is a cross-sectional view of the apparatus in a lowered position;

Figure 4 is a sectional view taken along lines 4 – 4 of Figure 3;

Figure 5 is a plan view of a frame for a slab of the apparatus;

Figure 6 is a cross-sectional view of the slab;

Figure 7 is a cross-sectional view of the apparatus in a raised position;

Figures 8 and 9 are an elevational view and a top view, respectively, of the apparatus of Figure 7;

Figures 10 and 11 are details of the apparatus of Figure 9; and

Figures 12 and 13 are a cross-sectional view of the apparatus according to a second embodiment of the invention in a lowered and raised position, respectively.

Referring to Figures 1 and 2 of the accompanying drawings, a domestic building 1 such as a house has a manual flood defence comprising the apparatus 2. The apparatus 2 comprises a plurality of slabs 3 rotatable about a horizontal axis 4 relative to a base 5. The slabs 3 are shown in solid lines in a horizontal lowered position and in dotted line in a vertical raised position. The slabs 3 are laid out as a path in a straight line between two permanent abutments 6 or buttresses and are parallel to an embankment wall 7 of a river 8. Further apparatus 2' extends from each of the abutments 6 at any angle, but here shown perpendicularly, to the apparatus 2 as part of the flood defence.

Referring to Figures 3 and 4, the base 5 comprises a channel structure 9 that has two side wall portions 10,11 and a bottom portion 12. An upstand 13 extends into the channel structure 9 from the bottom portion 12 and a protruding portion or footing 14 extends beneath the bottom portion 12. Spaced along the top of the upstand 13 are pairs of stub walls 15 supporting the ends of a roller bearing 16, there being a roller bearing 16 for each slab 3 of the apparatus 2. The roller bearing 16 forms a fulcrum for the slab 3. A slab 3 is shown in the horizontal lowered position and has a channel 17 fixed to the underside of each end portion 18 of the slab 3 perpendicular to the axis 4. The channels 17 are arranged so that they face a channel of the facing end portion of an adjacent slab. The slab 3 has a bracket 19 fixed to the underside of the slab 3 and the bracket 19 holds balancing weights 20. The bracket 19 is fixed in the region adjacent the side wall portion 10 furthest away from the building 1 to be protected. Recesses 21 are provided in the upstand 13 for receiving the bracket 19 and weights 20 when the slab 3 is raised. A C-shaped channel 22 spans the length of the channel structure 9 and its back is against the upstand 13. The C-shaped channel 22 contains a continuous seal 23, such as Neoprene, which faces the side wall portion 10 and protrudes beyond the channel 22. The C-shaped channel 22 is fixed to the upstand 13 by members 24 extending from the uppstand 13 to support the underside of the C-shaped channel 22.

The slabs 3 have struts 25 (shown in Figs. 7 and 9) which are adjustable in length and each strut 25 comprises two inter-sleeved tubes. The tubes are initially aligned so that holes in each are coincident and locked by pins. The struts 25 are hinged to channels 104 on the undersides of the slabs 3.

One end 26 of the slab 3, parallel to the axis 4, has pockets 27 aligned with an angle member 28 fixed on top of the side wall portion 10 and locking keys 29 extend from the pockets 27 into the angle member 28 to hold the slab 3 in a horizontal position. The opposite end 30 of the slab 3 rests on top of the opposite side wall portion 11 of the channel structure 9. The opposite end 30 of the slab 3 also has pockets 31 aligned with another angle member 32 on top of the opposite side wall portion and locking keys 29 extend from the pockets 31 into the angle member 32. The opposite side wall portion 30 faces the building 1 and is clad by brick or stone 33 supported by an extension 34 to the bottom portion 12 beyond the opposite side wall portion 11. The top surface 35 of the bottom portion 12 between the upstand 13 and the side wall portion 10 is coincident with the ground level that was existing before the apparatus 2 was constructed and the top surface 36 of the bottom portion 12 between the upstand 13 and the opposite side wall portion 11 is lower than the previous ground level. The side wall portion 10 has recesses 37 to hold plugs 38 as permanent fixings for "swing out" wedge struts 55.

Referring to Figures 5 and 6, the slab 3 has an edge frame 40 formed by L-shaped members 41. Five inverted T-shaped members 42 span between two opposing sides 43,44 of the frame 40 and two parallel sets 45,46 of aligned additional secondary inverted T-shaped members 47 span between the L-shaped members 41 and the T-shaped members 42 to form a 6 x 3 grid. Each square 48 of the grid has its edge 49 formed by the flanges 50 of T-shaped members 42,47, and often L-shaped members 41, and the flanges 50 around each square 48 support a plate 51. These plates 51 form a plate soffit.

The axis 4 of slab rotation is aligned underneath one of the sets 45 of aligned additional inverted T-shaped members 47 and a layer of lightweight

material 52, for example insulation such as "Jablite" (RTM), is laid on the plates 51 between the set 45 of inverted T-shaped members 47 and the L-shaped members 41 forming the side 44 of the frame closest to the building 1. The lightweight material 52 is laid up to the top of the inverted secondary T-shaped members 47. Another layer of the lightweight material 52 is laid above this and concrete 53 is then laid so that the whole frame 40 is completely infilled.

To form an active flood defence, the locking keys 29 are removed from the angle members 28,32 and the slabs 3 are tilted about their horizontal axis 4 to form a vertical flood barrier or dam as shown in Figures 7 to 9. The struts 25 are swung out from the undersides of the slabs 3, the pins are removed, and the distal ends of the struts 25 are wedged against the angle 32. A turnbuckle is turned on each strut 25 for a tight fit of the inter-sleeved tubes. The weighted brackets 19 are received in the upstand recesses 21 and the hinged wedge struts 55 are swung out horizontally from a closed position and wedged against surfaces 56 of the slabs 3 opposite the brackets 19. The struts 25,55 force the slabs 3 against the seal 23 held by the channel 22 to form a horizontal seal between the slabs 23 and the upstand 13.

To seal the gaps between adjacent slabs, a board 57 with a pair of continuous seals 58, such as Neoprene, on one surface 59 is slotted into the facing channels 17 and lowered so that the each seal 58 faces the inside of the arm 60 of the channel 17 adjacent the slab 3 (see Fig. 8). The pair of seals 58 are joined together by a seal portion 61 protruding beyond one end of the board 57 so that when the board 57 is lowered, the seal portion 61 forms a seal with the continuous horizontal seal 23 (see Fig. 10) protruding from the seal holding channel 22. A scissor action wedge 62 (see also Fig. 11) with tapered ends 63 is placed between the surface 64 of the board 57 opposite surface 59 and the arms 65 of the board holding channels 17 opposite arms 60 to wedge the seals 58,61 on the board 57 against the board holding channels 17.

The gap between each abutment 6 and an adjacent slab 3 are sealed in the same way.

The raised slabs 3 with the seals installed form a dam. The duct 103 formed on the dry side of the dam between the slabs 3 and upstand 13 and the opposite side wall portion 11 serves as a large drainage channel for collection of any water from leakages in the seal or water coming up through the ground on the dry side of the dam. Flood water arriving on the opposite side of the dam provide hydrostatic pressure to ensure safe sealing of the raised slabs 3.

When the active defence is no longer required, the boards 57 are removed and the struts 25,55 are swung back to their closed positions. For the struts 25, this involves counter-turning the turnbuckle, shortening the struts 25 by realigning the coincident holes of the inter-sleeved tubes and locking with the pins so that the struts 25 may rest clear of the stub walls 15 and the upstand 13. The slabs 3 are then rotated to their lowered horizontal position.

The slabs 3 can have any required finish. In a preferred embodiment, each slab 3 is approximately 3 metres long, 1.5 metres wide and 15 centimetres thick. The dimensions of L-shaped members 41 and the T-shaped members 42,47 are 150 x 75 mm, 100 x 100 mm and 50 x 50 mm, respectively, and the plate 51 used is 6 mm thick. The bearings 16 comprise 75 mm diameter tubes. Each end of each tube is welded to a plate which is welded to the underside of the slab. The tubes rest in half sections of tubes enabling a rotation to take place.

The stub walls 15 and the channel 9 (including its footing 14) are formed from reinforced concrete. The hinged struts 25 are 75 x 50 mm angle members and the hinged struts 55 comprise 100 x 75 mm timber struts at 1 metre centres. The sealing board 57 is of high density plastic and has the dimensions 1300 x 200 x 20 mm.

The depth of the footing 14 below the bottom portion 12 of the channel structure 9 is determined from a site investigation of the permeability of the soil and its strength characteristics to prevent the apparatus 2 from sliding or tilting. Referring to Figure 2, the building 1 has a finished floor level (FFL) and the apparatus has slabs of the dimensions mentioned above. The apparatus 2,

when the slabs 3 are in their horizontal lowered position, provides a maximum flood defence height of 1.45 metres above FFL. The axis 4 of rotation is positioned at a third of the width of the slab 3 in from its edge to meet the above criteria. If the apparatus is lowered relative to the FFL to provide a less intrusive view of the building 1 then the defence protection is obviously reduced and costs increased. The apparatus 2 is positioned a clear distance of at least 3 metres from the building 1 for ease of access. The lower top surface 36 of the bottom portion 12 of the channel structure 9 should be at least 50 mm below the previous existing ground level.

A modified apparatus 70 suitable for a public defence system is illustrated in Figures 12 and 13. The apparatus 70 is parallel to the embankment wall 71 of a river 72 and the slabs 73 of the apparatus 70 form a footpath 74 by a roadway 75 comprising a base 76 and a sub-base 77. The roadway 75 can provide access to the apparatus 70 for maintenance purposes.

The base 78 of the apparatus 70 comprises a channel structure 79 that forms a foundation. The channel structure 79 has two side wall portions 80,81 and a bottom portion 82 with an upstand 83 extending into the channel structure 79 from the bottom portion 82 and a footing 84 extending beneath the bottom portion 12. The top 85 of the bottom portion 82 on both sides of the upstand 83 are approximately level with each other.

Each slab 73 is hinged at one end 85 about a horizontal axis 86 from a protrusion 87 extending into the channel structure 79 along the length of the side wall portion 80 closest to the river 72 and the opposite end 88 of the slab 73 rests on a ledge 89 in the opposite side wall portion 81 of the channel structure 79. A portion 102 of the channel structure 79 spans between the side wall portions 80,81 on either side of the slab 73. A continuous seal 90 is laid on the top of the protrusion 87 and between the spanning portions 102 on either side of each slab 73. Inside the channel structure 79 between the upstand 83 and the opposite side wall portion 81 are hydraulic rams 91 which are connected to the

undersides of the slabs 73 and the undersides have fitted to them angle members 92 for receiving props.

Each slab 73 is between a pair of abutments 93 which are each shown as including a street light unit 94 and a bollard 95 and are above one of the spanning portions 102. Handrails 96 extend between the pair of abutments 93 and the posts 97 of the handrails 96 extend from the top of the side wall portion 80. An anti-scour slab 98 is provided between side wall portion 80 and the river wall 71 and is inclined downwardly towards the river 72.

The apparatus 70 is positioned so that the slabs 73 in their horizontal lowered position are above the ground level existing before the apparatus is constructed.

To form an active flood defence, the slabs 73 are tilted about their horizontal axis 86 by the hydraulic rams 91 being extended until the slabs 73 are raised to a position to form a vertical flood barrier or dam as shown in Figure 13 against the river 72' in flood. Adjustable props 99 are inserted at appropriate centres between the angle members 92 on the undersides of the slabs 73 and the ledge 89. Each raised slab 73 is forced against the continuous seal 90 on the top of the protrusion 87 to form a horizontal seal between the slab 73 and the protrusion 87.

The gaps between the abutments 93 and the slabs 73 are closed by pressure exerted by props 99 acting on vertical seals 106 fixed permanently for the full height on return fins 107 of the abutments 93.

In addition, the handrails 96 are removed between the abutments 93 and placed on top of the opposite side wall portion 81 of the channel structure 79.

The part of the channel structure 79 between the side wall portion 80 and the upstand 83 forms a duct 100 for flood drainage and the part of the channel structure 79 between the opposite side wall portion 81 and the upstand 83 can be used as a services duct 101.

In a preferred embodiment, the slabs 73 are made to fine tolerances at a precast concrete works and heavy craneage is used to lower the slabs 73 into position from the road 75 or river 72.

Whilst particular embodiments have been described, it will be understood that various modifications may be made without departing from the scope of the invention. For example, a variety of structural materials may be used for ease of construction, suitability in corrosive ground conditions, long life maintenance free characteristics and the economics of the installation. Also, additional measures to supplement the apparatus may be used such as pumps, which may be portable, to pump out any leakage around the seals via a continuous ducting system on the dry side of the dam. Sumps may be stategically placed for the use of the portable pumps to keep the flow of water in the duct at an acceptable level and the floor level of the duct should hence be at least 15 centimetres below the finished floor level of the building to be protected (see Fig. 2).

The size of the ducts of the channel structures 9, 79 are variable to suit the requirements of ancillary works for the apparatus. For example, the size of the hydraulic rams 91 may require the floor of duct 101 to be lower than the floor of duct 100.

The size of the apparatus may be adjusted to suit factors such as sloping ground, required height of the barrier and the length of the paved way. All support structures for the slabs, their bearings and strutting devices, together with any ducting, are subject to individual site conditions.

In the first embodiment, steps may be provided for access to the path from ground level. The side of the apparatus facing the building may have a planted mound instead of a brick or stone clad face and the abutments may be sized and shaped to suit landscaping requirements. The channel 22 may be supported by a metal plate fixed to the top of the upstand 13 where the plate acts as a barrier to the ingress of water around the seal 23.

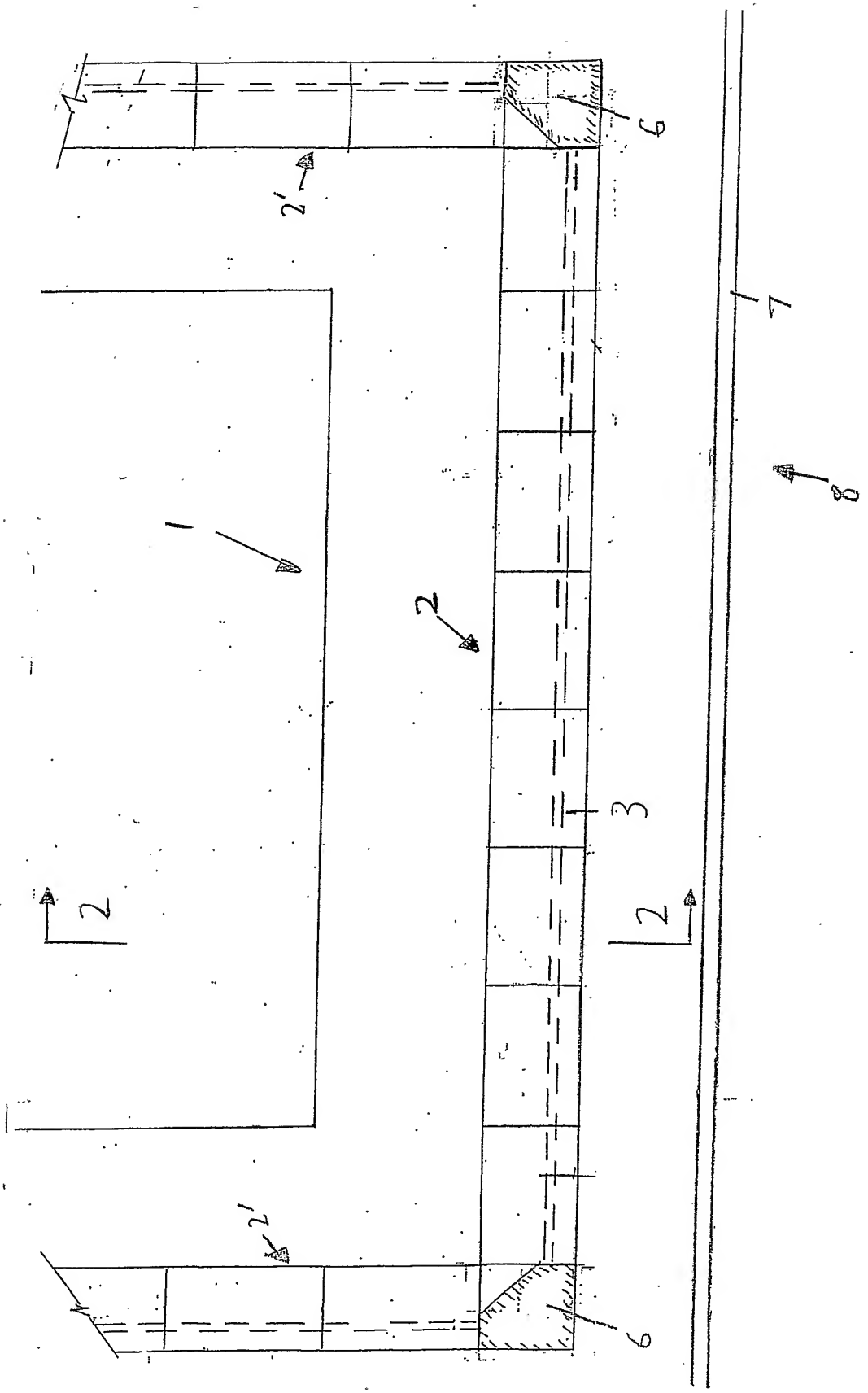

FIG. 1

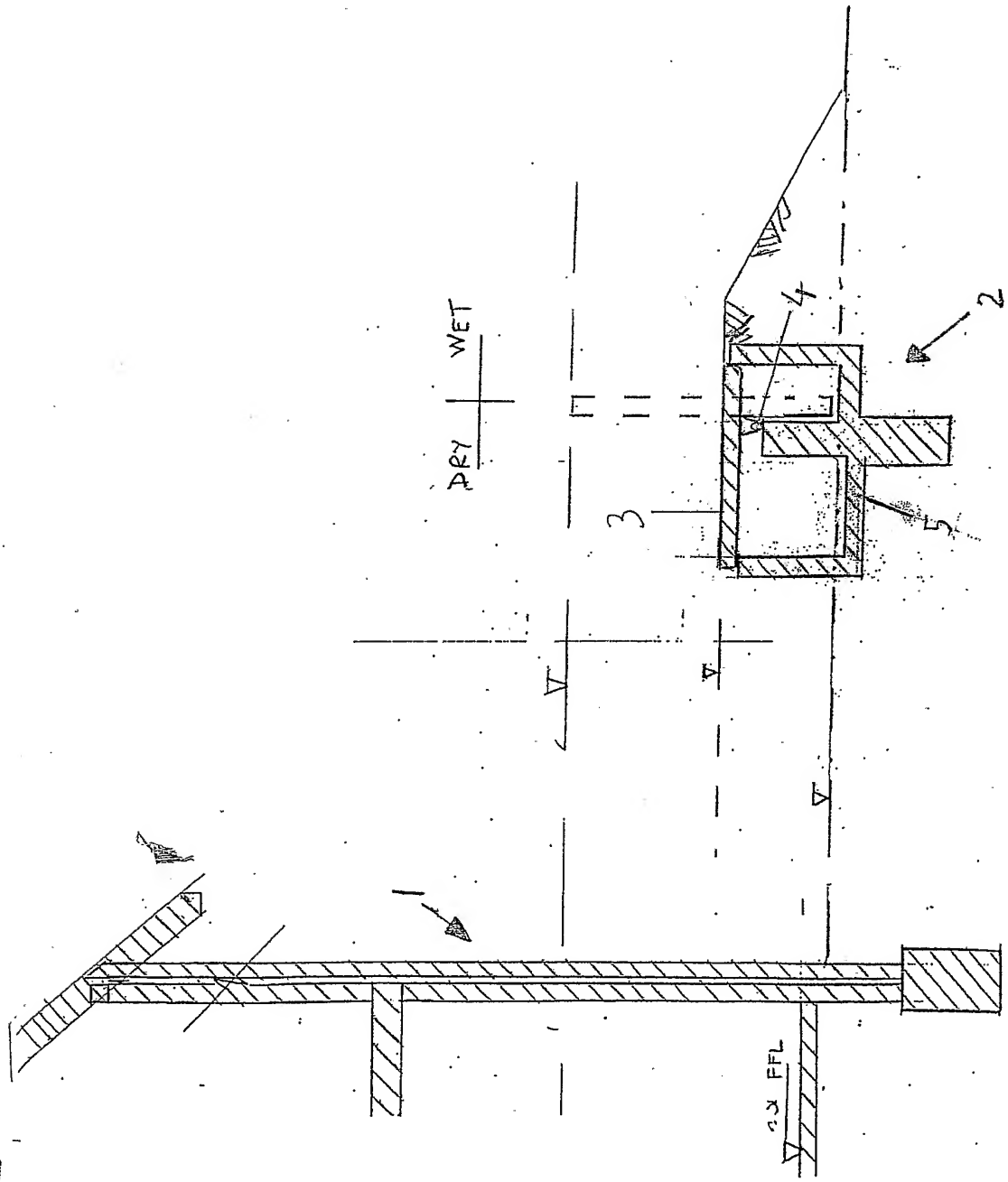

FIG. 2

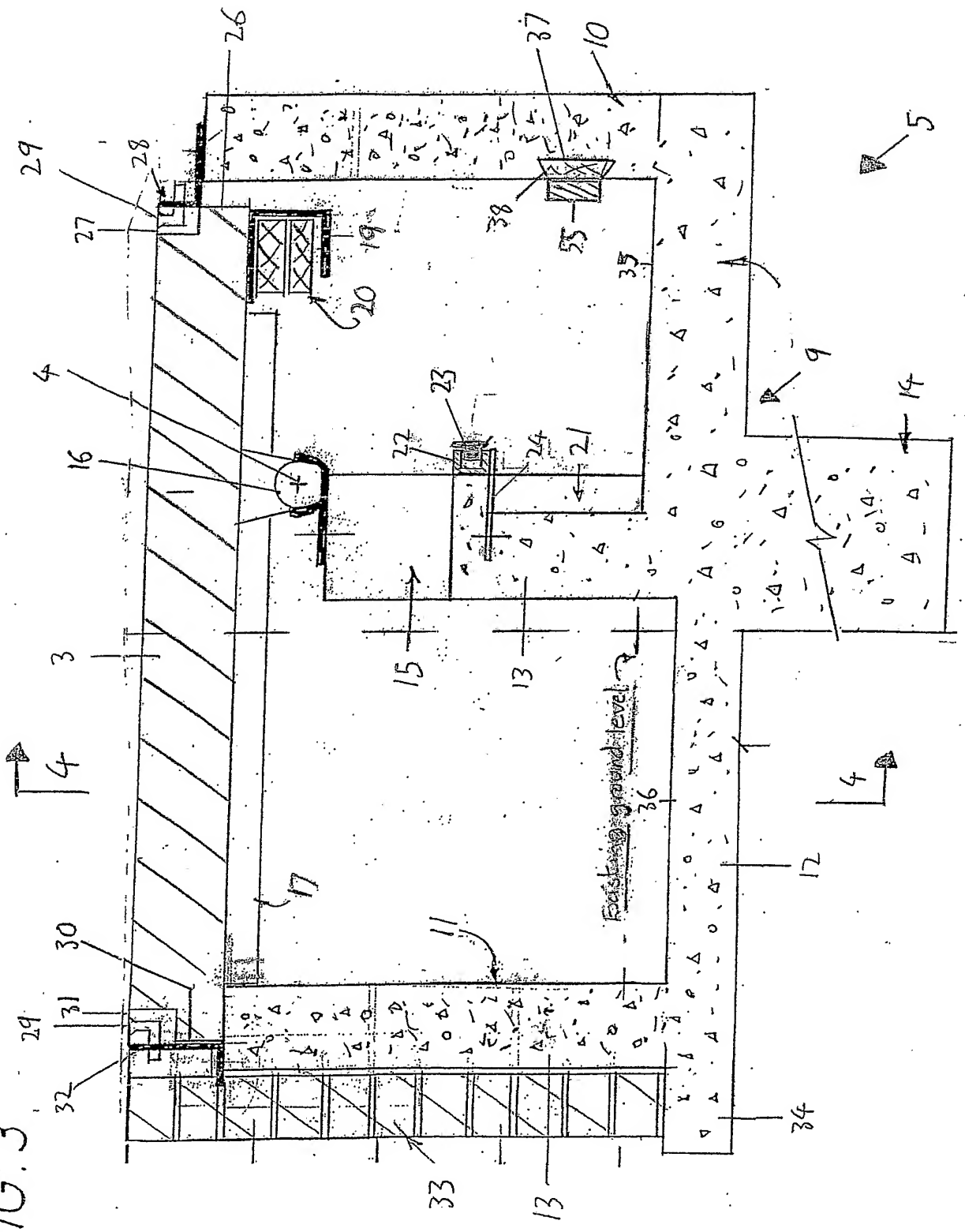

FIG. 3

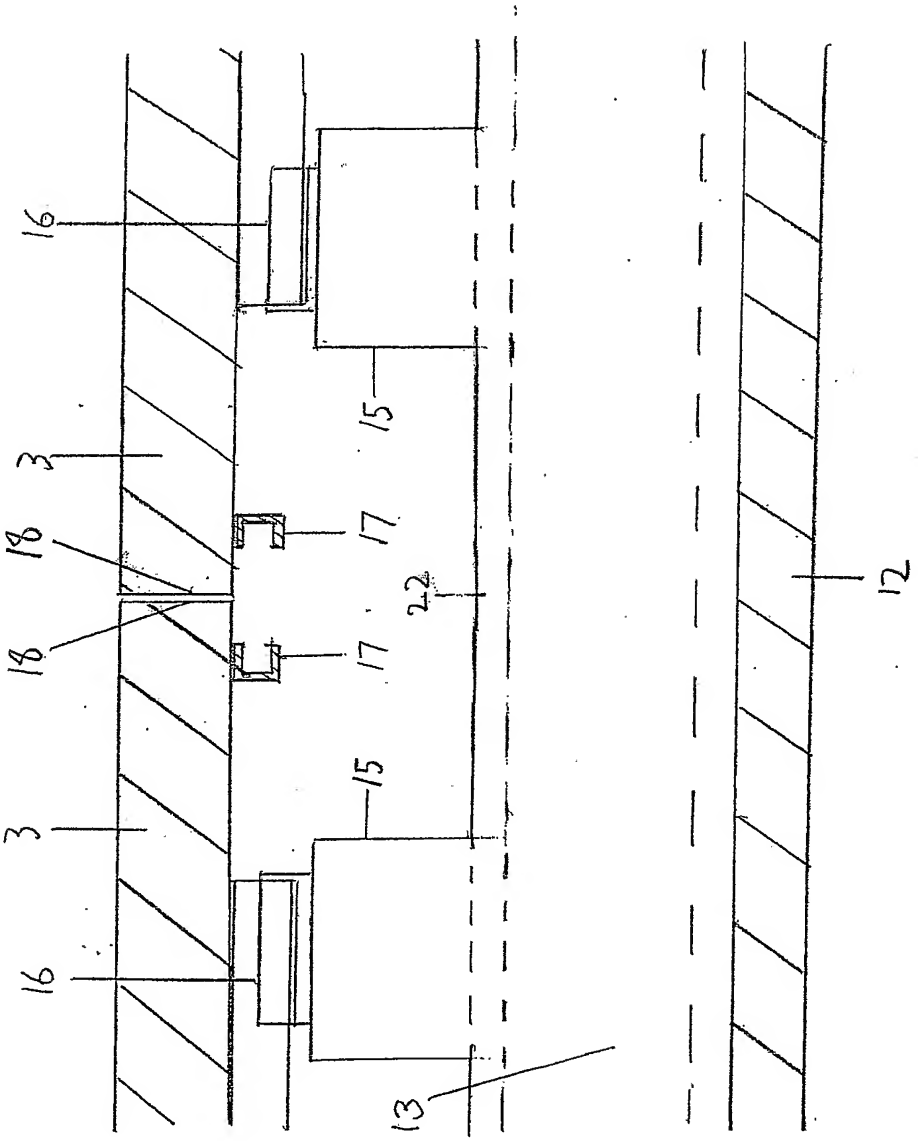

FIG. 4

FIG. 5

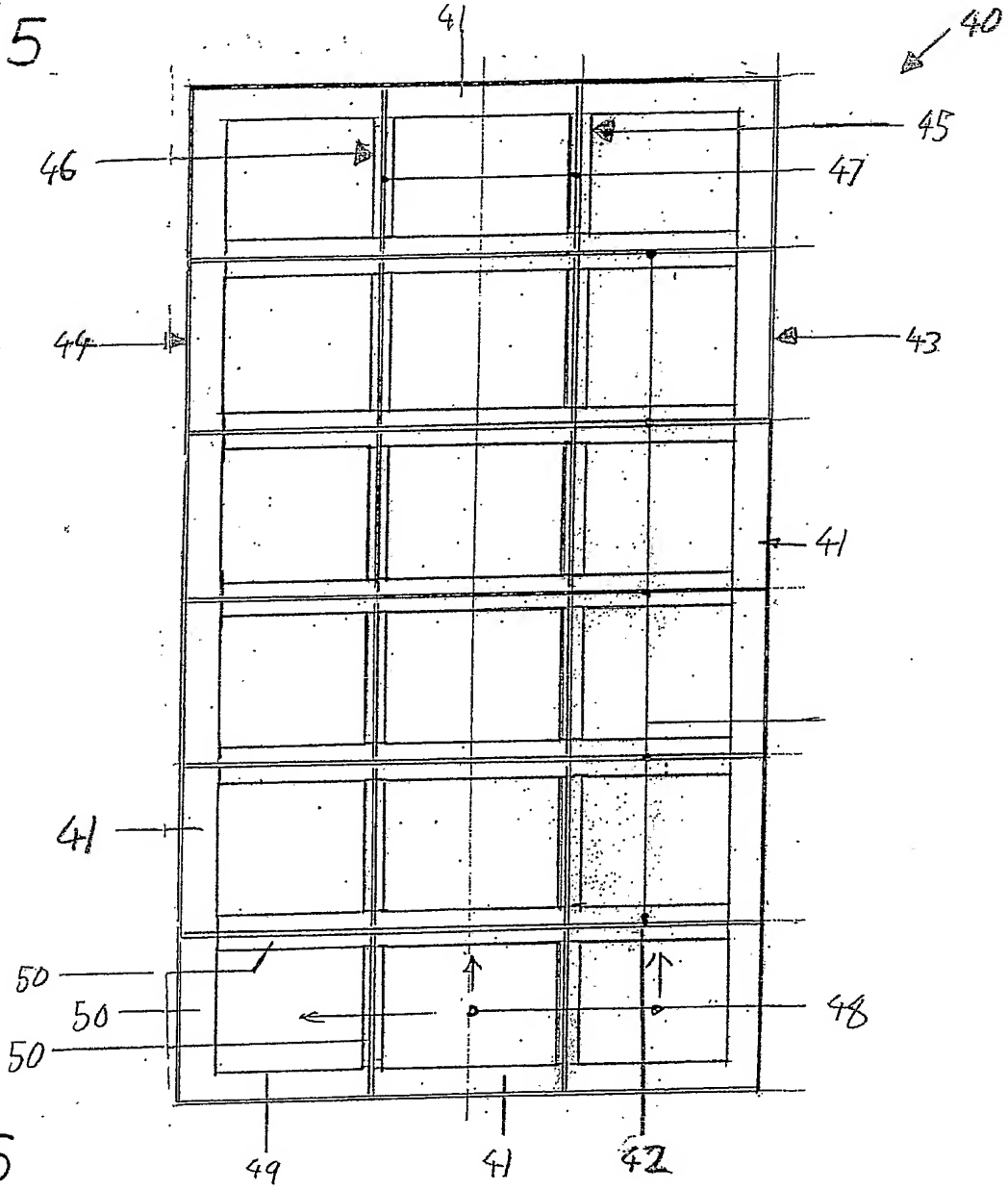
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FIG. 6

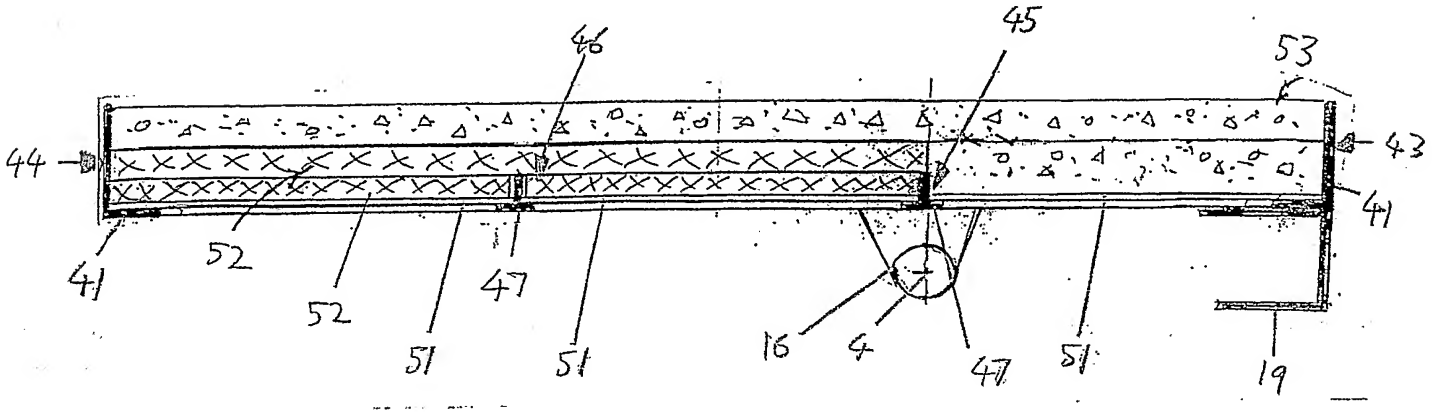
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FIG. 7

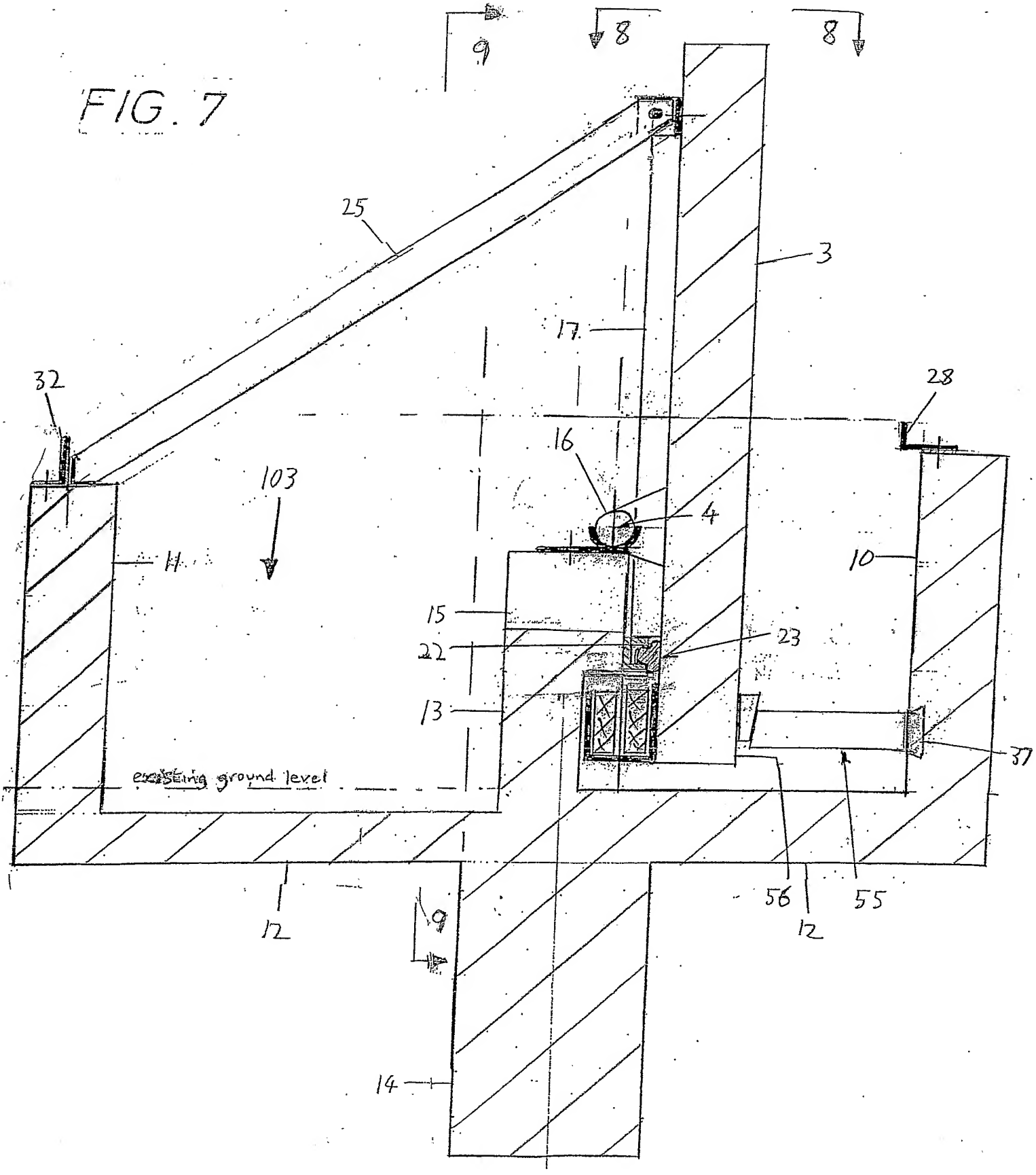
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FIG. 8

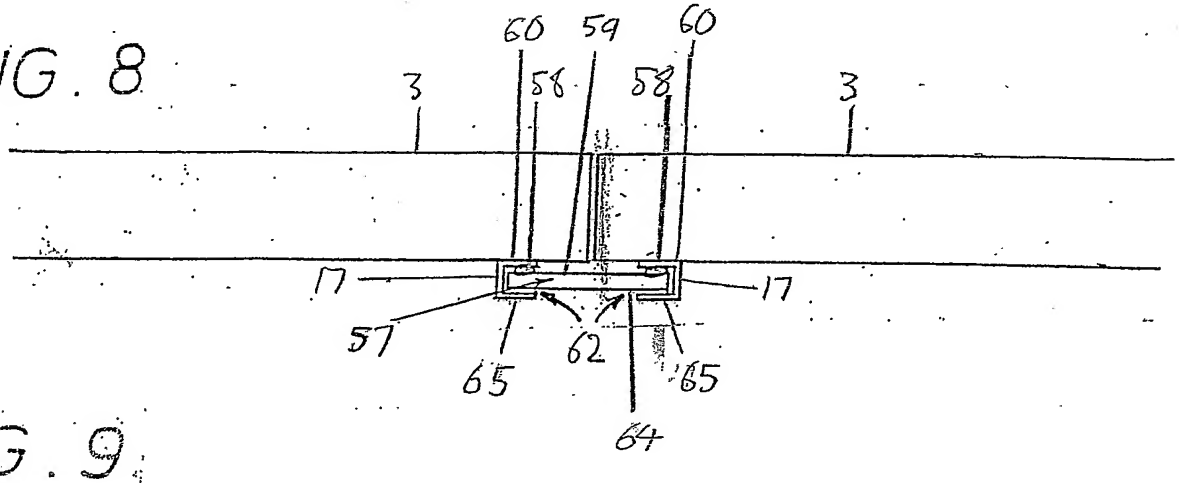
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FIG. 9

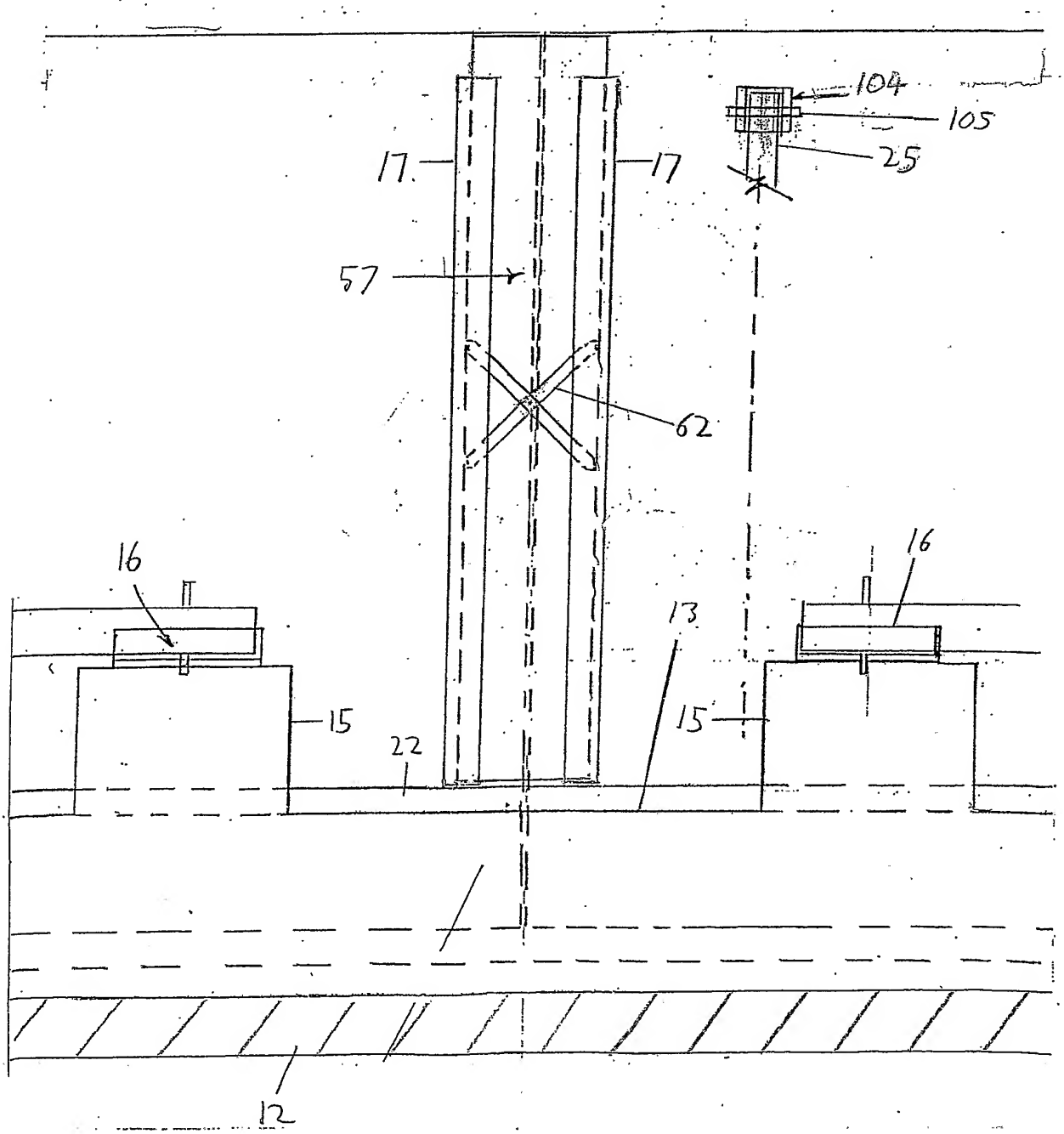
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FIG. 10

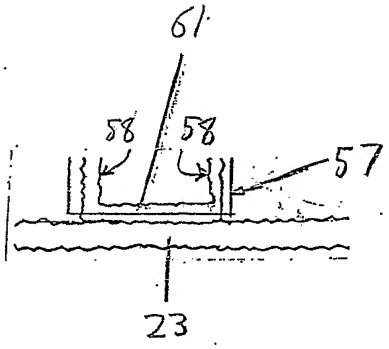
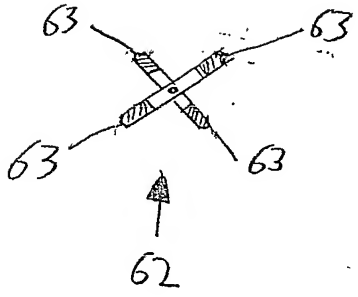


FIG. 11



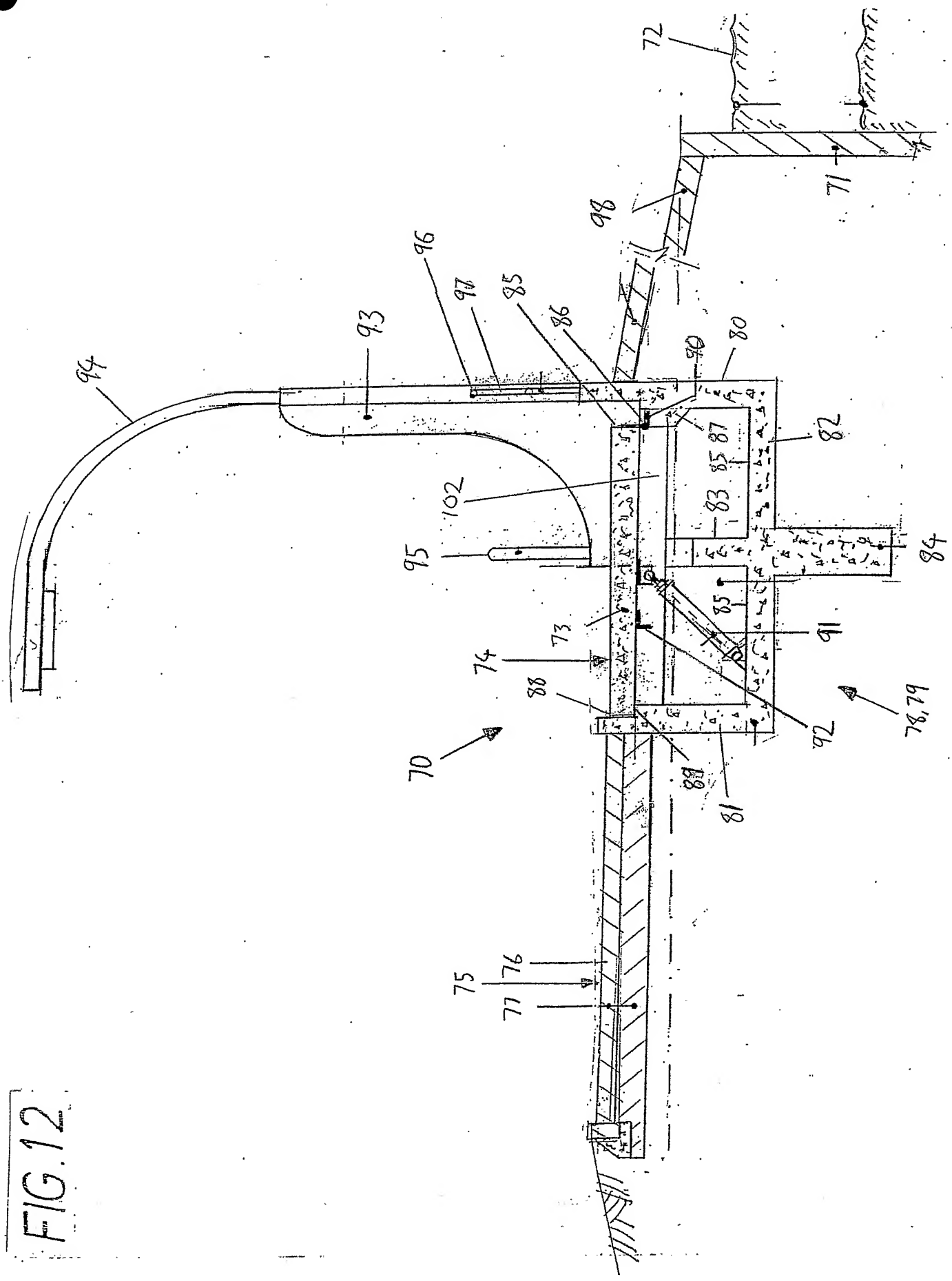

72
71
98
96
97
85
86
93
94
90
80
82
87
85
83
102
95
84
85
91
73
74
88
70
92
74'
84'
89
81
75
76
77

FIG. 12

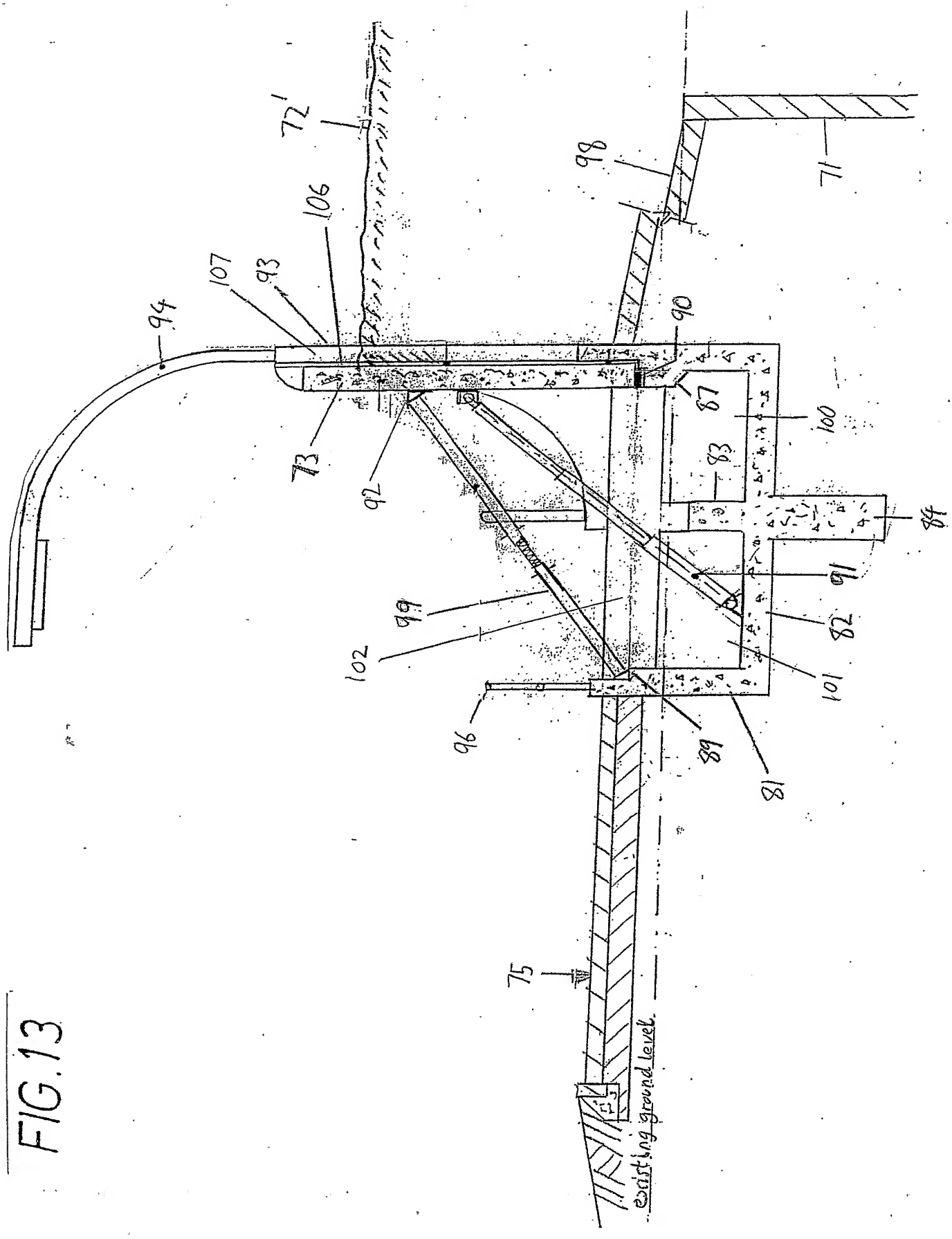

72'
98
71
106
107
93
94
90
73
92
87
100
83
84
91
99
102
82
101
96
89
81
75
existing ground level

FIG. 13